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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Sridhar K. Kailasam

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EXAMINER

RODGERS, COLLEEN E

ART UNIT

PAPER NUMBER

2813

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
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3 MONTHS

02/22/2007

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary

Application No.

10/705,579

Applicant(s)

KAILASAM ET AL.

Examiner

Colleen E. Rodgers

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 November 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-3, 6, 8-14 and 26-62 is/are pending in the application.
- 4a) Of the above claim(s) 29-54 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 59-62 is/are allowed.
- 6) ☒ Claim(s) 1-3, 6, 8, 9, 11-14, 26-28 and 55-58 is/are rejected.
- 7) ☒ Claim(s) 10 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

1. This Office Action responds to the Amendment filed 29 November 2006. By this amendment, claims 1, 2, 6, 8, 10, 11, 13 and 26-28 are amended, claims 4, 5, 7 and 15-25 are canceled and claims 55-62 are newly added. Claims 29-54 remain withdrawn pursuant to the restriction requirement dated 21 July 2006.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1-3 and 8 are rejected under 35 U.S.C. 102(b) as being anticipated by **Lu et al** (US Patent Application Publication 2002/0076929).

Regarding claim 1, **Lu et al** disclose a method for depositing copper on a work piece, the method comprising the steps of:

depositing overlying the work piece **100** a barrier layer **110** having a surface;

forming a protective layer **112** that overlies said surface of said barrier layer and that inhibits oxidation of said surface;

removing said protective layer [see paragraph 0018]; and

electrochemically depositing copper **124** overlying said barrier layer [see paragraph 0022].

Regarding claim 2, **Lu et al** disclose the method of claim 1, wherein the step of electrochemically depositing copper is by electroplating [see paragraphs 0004 and 0022].

Regarding claim 3, **Lu et al** disclose the method of claim 1, wherein the barrier layer comprises tantalum [see paragraph 0017].

Regarding claim 8, **Lu et al** disclose the method of claim 1, wherein the step of removing said protective layer comprises the step of removing said protective layer using an etchant [see paragraph 0019].

4. Claims 28 and 55-57 are rejected under 35 U.S.C. 102(e) as being anticipated by **Baskaran et al** (USPN 7,135,404).

Regarding claim 55, **Baskaran et al** disclose a method for depositing copper overlying a work piece, the method comprising the steps of:

depositing overlying the work piece 202 a barrier layer 204 having a surface;
removing from said surface of said barrier layer a contaminant, an oxide, or both by applying to said surface an initial cathode current pulse [see col. 9, lines 30-40]; and
after the step of applying to said surface of said barrier layer an initial cathode current pulse, electrochemically depositing copper 210 overlying said barrier layer.

Regarding claim 28, **Baskaran et al** disclose the method of claim 55, furthermore wherein an anodic current is applied to said surface of said barrier layer before the step of applying to said surface of said barrier layer an initial cathodic current pulse [see col. 9, lines 53-57].

Regarding claim 56, **Baskaran et al** disclose the method of claim 55, furthermore wherein the step of electrochemically depositing comprises depositing by electroplating [see col. 9, lines 13-15].

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Regarding claim 57, **Baskaran et al** disclose the method of claim 55, furthermore wherein the barrier layer is formed of tantalum or tungsten [see col. 1, lines 60-64].

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 6 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Lu et al** (US Patent Application Publication 2002/0076929).

Regarding claim 6, **Lu et al** disclose the method of claim 4 as described above. **Lu et al** do not disclose wherein the protective layer has a thickness no greater than about 20 Å. These claims are *prima facie* obvious without a showing that the claimed ranges achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art in general conditions is obvious). In this case, there exists no evidence of record that the thickness of the protective layer provides unexpected results in the

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semiconductor device produced. One of ordinary skill in the art would be motivated to optimize the protective layer's thickness to provide for processing limitations.

Regarding claim 11, **Lu et al** disclose the method of claim 4 as described above, furthermore wherein the step of forming the protective layer comprises forming a copper film 112. **Lu et al** do not disclose wherein the protective layer has a thickness less than 20 Å. These claims are *prima facie* obvious without a showing that the claimed ranges achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art in general conditions is obvious). In this case, there exists no evidence of record that the thickness of the protective layer provides unexpected results in the semiconductor device produced. One of ordinary skill in the art would be motivated to optimize the protective layer's thickness to provide for processing limitations.

7. Claims 26 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Baskaran et al** (USPN 7,135,404). **Baskaran et al** disclose the method of claim 55 as described above. **Baskaran et al** are silent as to the magnitude of the initial cathode current pulse, and also as to the time for which it is applied. These claims are *prima facie* obvious without a showing that the claimed ranges achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges

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of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art in general conditions is obvious). In this case, there exists no evidence of record that the magnitude of neither the cathodic current, nor the time for which it is applied, provides unexpected results in the semiconductor device produced. One of ordinary skill in the art would be motivated to optimize the magnitude and time to provide for processing limitations and device performance.

8. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Lu et al** (US Patent Application Publication 2002/0076929) in view of **Jung et al** (USPN 6,486,055). **Lu et al** disclose the method of claim 8. **Lu et al** do not disclose wherein the etchant comprises one of sulfuric acid, nitric acid and a combination of sulfuric acid and hydrogen peroxide. **Jung et al** disclose the step of exposing said surface of said barrier layer to an acidic solution which exposing the barrier layer to nitric acid [see col. 3, lines 33-37]. It would have been obvious to one of ordinary skill in the art at the time of invention to use nitric acid as an etchant because it is well known in the art that nitric acid is an extremely powerful oxidizing agent.

9. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Lu et al** (US Patent Application Publication 2002/0076929) in view of **Carl et al** (USPN 6,436,267). **Lu et al** disclose the method of claim 1. **Lu et al** are silent as to the method by which the barrier layer is deposited. **Carl et al** disclose a tantalum barrier layer formed by CVD [see paragraph bridging columns 18 and

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19]. It would have been obvious to one of ordinary skill in the art to deposit a tantalum barrier layer by CVD as taught by **Carl et al** because CVD is a well-known deposition method for refractory metals such as tantalum.

10. Claims 13 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Lu et al** (US Patent Application Publication 2002/0076929) in view of **Shingubara et al** (US Patent Application Publication 2003/0068887). **Lu et al** disclose the method of claim 1. **Lu et al** do not disclose wherein the step of depositing a barrier layer and the step of forming a protective layer are performed in the same processing apparatus. **Shingubara et al** disclose a substantially similar method, wherein the step of depositing a barrier layer and the step of forming a protective layer are performed in the same processing apparatus, and in the same processing chamber [see paragraph 0027]. It would have been obvious to one of ordinary skill in the art at the time of invention to perform the steps of depositing a barrier layer and forming a protective layer in the same apparatus in order to reduce the possibility of oxidation and other forms of contamination during the transferal of the work piece.

11. Claim 58 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Baskaran et al** (USPN 7,135,404) in view of **Carl et al** (USPN 6,436,267). **Baskaran et al** disclose the method of claim 55. **Baskaran et al** are silent as to the method by which the barrier layer is deposited. **Carl et al** disclose a tantalum barrier layer formed by CVD [see paragraph bridging columns 18 and 19]. It would have been obvious to one of ordinary skill in the art to deposit a tantalum barrier layer by CVD as taught by **Carl et al** because CVD is a well-known deposition method for refractory metals such as tantalum.

Allowable Subject Matter

12. Claim 10 is objected to as being dependent upon a rejected base claim for reasons deemed to be of record, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

13. Claims 59-62 are allowed.

14. The following is a statement of reasons for the indication of allowable subject matter: the prior art of record fails to teach or make reasonably obvious, in combination with the other claimed features, wherein a protective layer is formed over a barrier layer by exposing the surface of said barrier layer to a phosphorous- or a sulfur-containing gas.

Response to Arguments

15. Applicant's arguments filed 29 November 2006 have been fully considered but they are not persuasive. On pages 12 and 13 of the Remarks, with respect to the rejection of claims 1-4, 6-8 and 11 [1-4, 7 and 8 under 35 U.S.C. §102(b) and 6 and 11 under 35 U.S.C. §103(a)], Applicants argue that **Lu et al** do not discuss removing the passivation layer. The Examiner disagrees. **Lu et al** disclose that a seed layer 112 is deposited and over time the condition of the seed layer degrades, leading to an etch process by which the compromised seed layer is removed.

Furthermore, on pages 13-14 of the Remarks, Applicants argue that neither **Lu et al** nor **Jung et al** disclose removing a protective layer. The Examiner disagrees for the reasons provided above.

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16. Applicant's arguments with respect to the rejections under **Nogami et al** (claims 1-6), **Itabashi et al** (claims 1-4, 11, 12, 19 and 21-24), **Shingubara et al** (claims 1-6, 13 and 14) and **Lu et al** in view of **Ding et al** (claims 25-28) have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

17. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Colleen E. Rodgers whose telephone number is (571) 272-8603. The examiner can normally be reached on Monday through Friday, 9:00 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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